

The Australasian genus *Schizacme* (Loganiaceae): new combinations and new species in the New Zealand flora

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Abstract

Schizacme Dunlop (Loganiaceae) is a genus of five perennial subshrubs of predominantly alpine and montane habitats in south eastern Australia and in New Zealand. *Schizacme* was described as a segregate from *Mitrasacme* Labill. but combinations in the genus were not made for two New Zealand taxa, *Mitrasacme montana* Hook.f. var. *helmsii* Kirk and *M. novae-zealandiae* Hook.f., thought to be congeneric with *Schizacme*. By using nucleotide sequence data from the nuclear ribosomal ETS and the chloroplast intron *petD*, we confirm that New Zealand *Mitrasacme* and Australian *Schizacme* form a monophyletic group. New combinations are created in *Schizacme* and species limits are reviewed, with an emphasis on the New Zealand taxa. *Mitrasacme montana* var. *helmsii* is here elevated to species rank, as *S. helmsii* (Kirk) K.L.Gibbons. *Schizacme ciliata* K.L.Gibbons is here described as a segregate from *S. novae-zealandiae* (Hook.f.) K.L.Gibbons. The morphology of *Schizacme*, including the New Zealand species, is discussed.

Introduction

Schizacme Dunlop is a genus of perennial subshrubs in south-eastern Australia and in New Zealand. These species are mat or cushion-forming plants of predominantly alpine and montane habitats, with *S. montana* (Hook.f. ex Benth.) Dunlop extending to sea level in south-western Tasmania. *Schizacme* was described as a segregate genus from *Mitrasacme* Labill., together with the Australian endemic, *Phyllangium* Dunlop (Dunlop 1996b, 1996c). Previously placed in Spigeliaceae (Loganiaceae), these three genera are now placed in Loganiaceae together with other Australasian representatives of the family (Backlund et al. 2000, Struwe 2004, Heywood et al. 2007, Gibbons et al. 2012). Dunlop (1996c) made two combinations in Australian *Schizacme*, *S. archeri* (Hook.f.) Dunlop and *S. montana*. In this publication, he indicated that the New Zealand taxa *Mitrasacme montana* Hook.f. ex Benth. var. *helmsii* Kirk and *M. novae-zealandiae* Hook.f. were conspecific with species of *Schizacme*, but he did not make the necessary nomenclatural combinations. In failing to formally transfer *M. montana* var. *helmsii* to *Schizacme*, the autonomous varietal name *Schizacme montana* (Hook.f. ex Benth.) Dunlop var. *montana* was not available for use, even though it was referred to by Dunlop (1996c, p. 58).

This paper is dedicated to the memory of our friend and colleague, Elizabeth Anne Brown (1956–2013). Although Elizabeth was well known as a bryologist and for her work on Ericaceae, she was also one of the very few botanists to have studied Loganiaceae in Australia.

Schizacme and *Phyllangium* have not been accepted by all authors, as it was thought these genera might be derived from within *Mitrasacme* (Struwe 2004). However, a recent molecular phylogenetic study (Gibbons et al. 2012) supports Dunlop's genera and places *Schizacme* sister to *Phyllangium*, with *Mitrasacme* sister to its segregates. In describing *Schizacme*, Dunlop (1996c) cited a number of morphological characters that separate the genus from *Mitrasacme*. These were their penninerved leaves (one nerved or triplinerved in *Mitrasacme*); heteromorphic calyx (with two dissimilar pairs of lobes); apical-axile, elongated placenta; flattened, woody capsule; and styles withering in fruit. With the inclusion of the New Zealand species, the morphological circumscription of *Schizacme* requires refinement. However, the genus is readily separable from other Loganieae based on morphological features, and its capsules are particularly distinctive.

In a recent molecular phylogenetic study (Gibbons et al. 2012), only one Australian species of *Schizacme* was included, the Tasmanian endemic *S. archeri*. *Mitrasacme* was represented only by *Mitrasacme* subgen. *Mitrasacme*, because representatives of subgen. *Schizogyne* Dunlop and subgen. *Plecocalyx* (G. Don) Dunlop were unavailable. It is now timely to confirm the monophyly of *Mitrasacme* and *Schizacme* with nucleotide sequence data from additional taxa, and to refine Dunlop's morphological concept of *Schizacme*, including the New Zealand taxa currently remaining in *Mitrasacme*. These taxa have been little studied and a review is presented before new combinations in *Schizacme* are made.

In describing *Mitrasacme montana* var. *helmsii*, Kirk (1890, p.446) cited the following characters as distinguishing his variety from the typical form, occurring in Australia: "the more densely matted habit, the longer calyx, in the peduncles being absent, or never elongated even in fruit, and in having the compressed fruits produced into curved lateral filiform processes". Cheeseman (1906) and Dunlop (1996c) have both suggested that the rank of *M. montana* var. *helmsii* requires further evaluation.

Mitrasacme novae-zelandiae was described by Hooker in the 'Handbook of the Flora of New Zealand' (Hooker 1867); included only in the "Additions, Corrections, &c.", the protologue was brief and did not include an illustration. Cheeseman (1906, p. 442) refers to a Cockayne specimen (Hills' Peak, 1360ft, *L. Cockayne* 5656, without date, WELT-SP011225) with "narrower leaves and shorter bristle points", which Cheeseman suggested might constitute a separate species. Allan (1961) further notes that forms similar to that collection occur in Fiordland and Stewart Island. However, the morphological variation within *Mitrasacme novae-zelandiae* as currently circumscribed, and its taxonomic significance, have not been formally evaluated before now.

The aim of this study is to confirm that the New Zealand taxa *Mitrasacme montana* var. *helmsii* and *M. novae-zelandiae* are congeneric with Australian species of *Schizacme* using nucleotide sequence data. The morphological circumscription of *Schizacme*, as defined by Dunlop (1996c), is evaluated. A brief review of species limits in the genus, with an emphasis on the New Zealand taxa, is provided.

Methods

Molecular phylogenetic study: Taxonomic sampling included all currently recognised species and varieties of *Schizacme* and New Zealand *Mitrasacme*. Other new sequences included in this study were of *M. secedens* Dunlop (subgen. *Schizogyne*), *M. foliosa* C.A. Gardner and *M. laxiceps* Dunlop (subgen. *Plecocalyx*) and *Phyllangium sulcatum* Dunlop. *Adelphacme minima* (B.J. Conn) K.L. Gibbons, B.J. Conn & M.J. Henwood (syn. *Mitreola minima* B.J. Conn) was used as the outgroup because it was placed sister to *Mitrasacme*, *Schizacme* and *Phyllangium* with strong support in a previous study (Gibbons et al. 2012). Details of all accessions included in this study and GenBank numbers are given in Appendix 1.

DNA was extracted from silica-dried leaf material and amplified for the chloroplast intron *petD* and the nuclear ribosomal external transcribed spacer (ETS) according to the methods given in Gibbons et al. (2012). Sequencing was carried out by the Australian Genome Research Facility (Westmead, NSW). Assembly and editing of contiguous sequences was carried out using SEQUENCHER version 4.5 (Gene Codes Corporation, Ann Arbor, Michigan, USA). Sequences were aligned using MUSCLE (Edgar 2004) with substantial manual optimization performed in MESQUITE version 2.75 (Maddison and Maddison 2011). Bayesian phylogenetic analyses were carried out in MRBAYES 3.1.2 (Huelsenbeck and Ronquist 2001, Ronquist and Huelsenbeck 2003) with no regions excluded from analysis. Support for clades was provided by posterior probabilities (p.p.), with p.p. \geq 0.95 considered to provide support. Analyses were carried out with two independent runs each of four chains (one cold chain and three heated chains), with a heating temperature of 0.2. The preferred nucleotide substitution model was determined in jMODELTEST 0.1.1 (Guindon and Gascuel 2003, Posada 2008) using the Akaike information criterion (Akaike 1974) and three substitution schemes (JC, HKY and GTR). For both markers, the GTR+G model was preferred. Analyses were run for 1,000,000 generations, sampling every 1000 generations, with the first 250 trees (25%) discarded as burn-in. Adequate convergence and mixing was

evidenced by an average standard deviation of split frequencies < 0.01 , estimated sample sizes of all parameters > 200 and examination of parameter output trace files in TRACER v 1.5.0 (Rambaut and Drummond 2009). Analyses including insertion/deletion (indel) characters, generated in SEQSTATE version 1.4.1 (Müller 2005) using simple indel coding (Simmons and Ochoterena 2000), were very similar to those using substitution characters alone. Therefore, analyses of substitution characters only will be shown below. The partition homogeneity test (Mickeych and Farris 1981, Farris et al. 1994), as implemented in PAUP* version 4.0b10 (Swofford 2002), was used to test congruence of the *petD* and ETS datasets. Simulations were performed with 1000 replicates of heuristic tree searches with 10 random addition sequence replicates and tree-bisection reconnection (TBR) branch swapping, saving a maximum of 2000 trees per replicate. The two datasets were found to be congruent ($p = 0.8$) and analyses were carried out for each marker individually and for the concatenated data set (with the two markers run as unlinked partitions).

Morphological study: Morphological data were obtained from herbarium collections held at CHR, HO, NSW and WELT. All measurements were carried out on dried herbarium material using a WILD M3C stereomicroscope. Ten specimens of *M. montana* var. *helmsii* and 20 specimens of *M. novae-zelandiae* were available for study. Australian specimens examined are cited summarised by distribution according to the regions of Victoria (Conn 1993) and Tasmania (Orchard 1988). New Zealand specimens examined are summarised according to botanical provinces defined by Wardle (1991).

Results

Molecular phylogenetic results: The New Zealand taxa currently placed in *Mitrasacme* and Australian *Schizacme* together form a well-supported (p.p. = 1) monophyletic group in individual analyses of nuclear ribosomal (ETS) and chloroplast (*petD*) nucleotide sequence data (Figs 1a, b) and of the concatenated dataset (Fig. 2). *Mitrasacme novae-zelandiae* is placed sister to the remainder of *Schizacme* and New Zealand *Mitrasacme*. *Mitrasacme montana* var. *helmsii* was not placed sister to Australian material of *S. montana*. In the analysis of ETS, *M. montana* var. *helmsii* is sister to *S. archeri*, but without support (p.p. = 0.93). In analyses of *petD* and the concatenated dataset, a sister relationship between the two Australian species of *Schizacme* is supported. Branch lengths separating *M. montana* var. *helmsii* from other taxa are comparable to those between other species. These findings support the elevation of the rank of *M. montana* var. *helmsii* to species and the transfer of the New Zealand taxa to *Schizacme*, as formalised below.

Mitrasacme and *Phyllangium* are each resolved as monophyletic (p.p. = 1) in all analyses. The sister relationship between *Schizacme* and *Phyllangium* found in the previous study (Gibbons et al. 2012) is again resolved. Although this sister relationship does not receive support in the analysis of *petD*, it is supported in analyses of ETS and of the concatenated dataset. Interspecific relationships within *Mitrasacme* are not shown here because a more taxonomically complete phylogeny of *Mitrasacme* is in progress and will be the subject of a future paper.

Morphological variation: *Mitrasacme montana* var. *helmsii* differs from Australian material of *Schizacme montana* by the morphological characters listed in Table 1 and warrants recognition at species rank. Therefore, the new combination, *S. helmsii* (Kirk) K.L.Gibbons, is made below. We did not find, as stated by Kirk (1890), that the habit of this species was more ‘densely matted’ than that of *S. montana*. The calyx of *S. helmsii* is also generally shorter than that of *S. montana*, not longer as stated by Kirk, although calyx dimensions in *S. helmsii* overlap with smaller individuals of *S. montana*.

Table 1. Major morphological differences between *Schizacme helmsii* and *S. montana*.

Species	<i>Schizacme helmsii</i>	<i>Schizacme montana</i>
Leaves	2.5–4.5(–6) mm long (including petiole), 1.4–2.2 mm wide; margin never ciliate	5–12 mm long (including petiole), 1.5–5 mm wide; margin occasionally ciliate
Pedicels	Up to 0.5 mm long (in flower), 0.2–1.3 mm long (in fruit); glabrous.	2–6(–14) mm long (in flower), 2–35 mm long (in fruit); pilose or occasionally glabrescent (in fruit).
Calyx	Lobes narrowly triangular to narrowly ovate; tube and lobes glabrous	Lobes ovate or elliptic; tube pilose or glabrescent, lobes ciliate, often pilose or papillose on abaxial surface
Styles	1.3–1.9 mm long (in flower)	1–1.2 mm long (in flower)

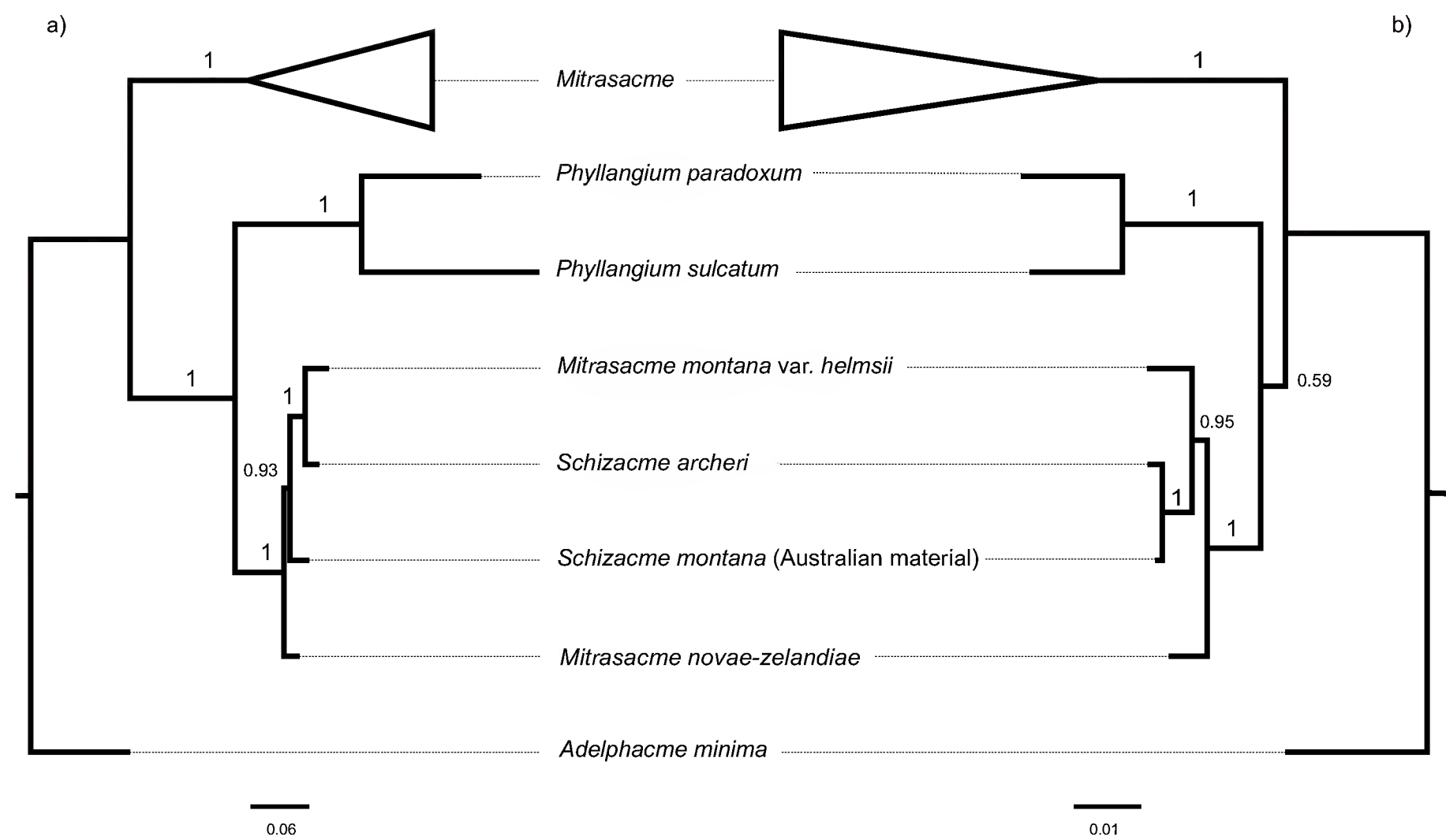


Fig. 1. Majority-rule consensus of the Bayesian analysis of substitution characters of *Mitrasacme* and *Schizacme*, with *Adelphacme* as outgroup: **a.** ETS; **b.** *petD*. Posterior probabilities are shown above branches. Scale is in estimated substitutions per site.

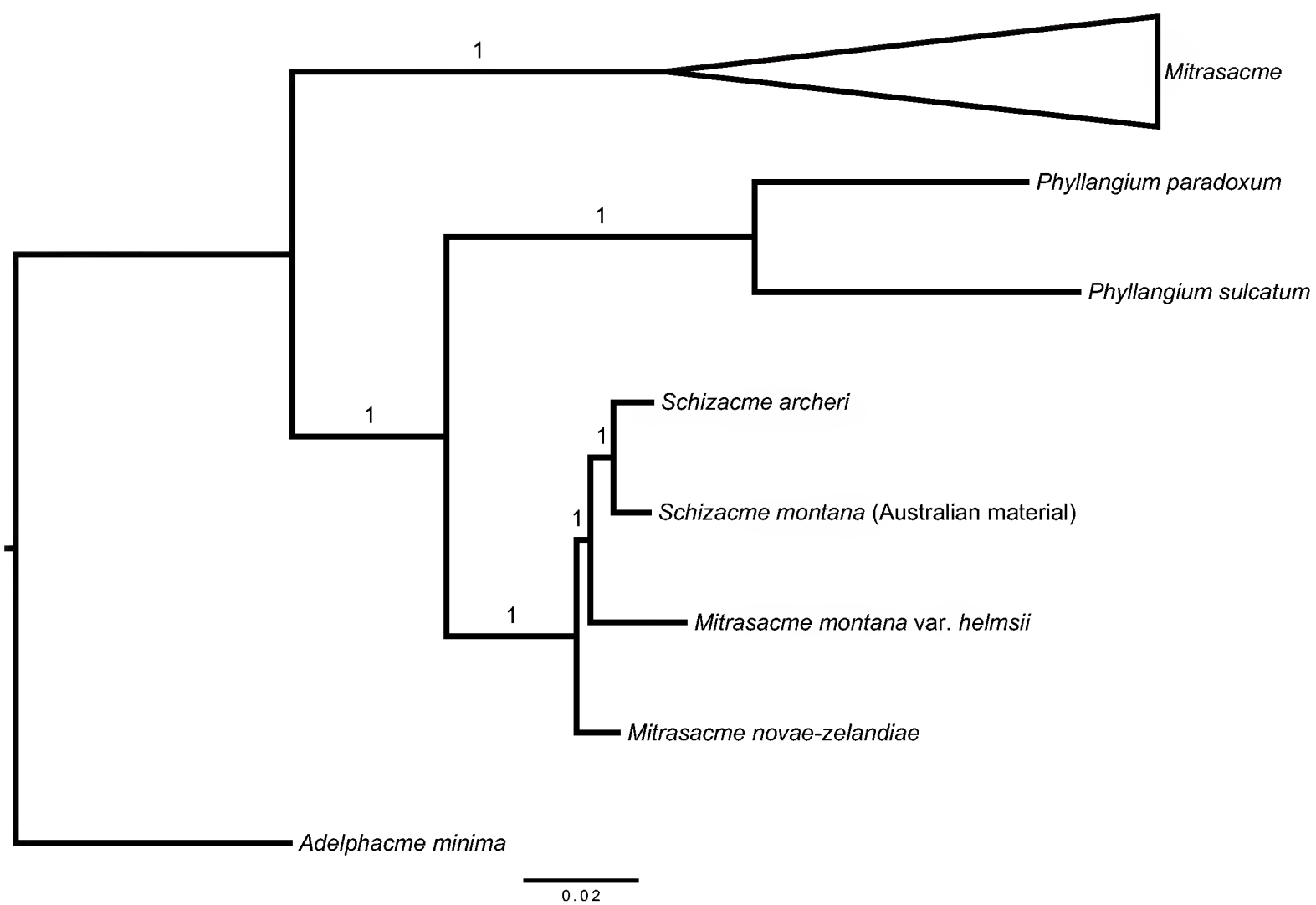


Fig. 2. Majority-rule consensus of the Bayesian analysis of the concatenated dataset (ETS and *petD*) of *Mitrasacme* and *Schizacme*, with *Adelphacme* as outgroup. Posterior probabilities are shown above branches. Scale is in estimated substitutions per site.

Plants from Stewart Island, some from Fiordland (South Island) and some from Arthur's Pass, Canterbury (South Island) are morphologically distinct from *M. novae-zealandiae*, differing by the characters given in Table 2. They are here described as the new species *Schizacme ciliata* K.L.Gibbons. For clarity, we use the new names and new combinations in the discussion below before their formalisation in the taxonomy section at the end of this paper.

Table 2. Major morphological differences between *Schizacme ciliata* and *S. novae-zealandiae*

Species	<i>Schizacme ciliata</i>	<i>Schizacme novae-zealandiae</i>
Leaves	oblong to obovate, 0.8–1.4 mm wide, margin distinctly hyaline (clearly visible without magnification), usually with ciliate hairs at base, hyaline apiculum 0.1–0.8(–1.4) mm long	linear-oblong, 0.5–0.9 mm wide, if margin hyaline then narrowly so, glabrous, hyaline apiculum 0.1–0.5 mm long
Corolla	tube c. 1.2 mm long lobes 1–1.4 mm long, 0.4–0.8 mm wide	tube 1.7–3 mm long lobes 0.6–1 mm long, 0.8–1.2 mm wide

Discussion

Unlike an earlier molecular phylogenetic study (Gibbons et al. 2012), this study includes all previously described taxa attributable to *Schizacme* and provides molecular support for the genus, including all New Zealand species previously placed in *Mitrasacme*. Concurrent examination of Australian and New Zealand material has allowed us to further discuss the morphology of *Schizacme*.

Schizacme is defined by its distinctive winged capsules (Figs 3, 4d). This feature provides a qualitative difference between the capsules of *Schizacme* and the superficially similar capsules of *Mitreola* L. and *Mitrasacme* subg. *Schizogyne*. Bentham (1857) and Hooker (1859) both described the 'inflection' of the carpel walls of *S. montana*. The carpel walls appear reflexed beyond the ventral suture, thus forming the wings. This interpretation of carpel morphology in *Schizacme* is consistent with the theory of carpel development by the conduplicate folding of a leaf-like organ (Simpson 2010). The precursor of the wings can be seen as lobes at the apex of the ovary (Fig. 4c), suggesting these wings are present from gynogenesis rather than developing during maturation of the capsule.

The styles of *Schizacme* are free but connivent at anthesis, compared with the connate styles of *Adelphacme* and *Mitrasacme* (excluding *M. secedens*). In *Phyllangium*, this trait is variable. In *M. alsinoides* R.Br., postgenital fusion of the styles has been studied and has been hypothesised to facilitate pollen selection by enabling development of a compitum (Endress et al. 1983). Breeding systems and pollination in *Schizacme* have not been studied, but it seems reasonable to hypothesise that the inconspicuous flowers of this genus are at least facultatively self-fertilising.

The capsules of *S. novae-zealandiae* and *S. ciliata* differ somewhat from those of the remaining species of *Schizacme*, being only slightly flattened, similar to those of *Mitrasacme* and *Phyllangium*. The capsules of *S. archeri*, *S. helmsii* and *S. montana*, which form a clade in this study, are strongly compressed at a plane 90° to the septum, appearing broadly cuneiform in lateral view. These capsules are distinctly semi-apocarpous, with the free (distal) portion of the carpels very broadly divaricate and the wings forming a sheath between them (Fig. 4d). The locules are elongate and oblique. In contrast, the locules of *S. novae-zealandiae* and *S. ciliata* are more or less ovoid, with only the apex of the locules free, and the wings predominantly distal to the locules.

Schizacme is further distinguished from other Loganieae by its few-seeded placentation. Dunlop (1996c) describes placentation in the Australian species *S. archeri* and *S. montana* as elongate. Although placentation in *S. novae-zealandiae* and *S. ciliata* could not be clearly seen in the material available, the ovoid locules are not suggestive of an elongate placenta. It is likely that in all species placental attachment is along the ventral suture, which in the free portion of the carpels is continuous with the septum in the proximal fused portion of the carpels. Therefore, placentation is best described as axile. Reduction in seed number is consistent with the perennial life history of *Schizacme*, compared with the (predominantly) annual and ephemeral *Mitrasacme* and the annual *Adelphacme* and *Phyllangium*.

Other characteristics distinguishing *Schizacme* from *Mitrasacme* are differences in leaf venation and the often heteromorphic calyx of *Schizacme*. Leaf venation in *Schizacme* appears penninerved or one-nerved, as it is in other genera of Loganieae. In *Mitrasacme*, leaf venation is often triplinerved. Plinerved leaf venation is not



Fig. 3. *Schizacme archeri* and *S. montana*, showing leaves and capsules. **a.** *Schizacme archeri* (M.J. Henwood 865); **b.** *Schizacme montana* (M.J. Henwood 937). Images: M.J. Henwood. Scale bar: 4 mm.

unknown in Loganiaceae, occurring also in *Strychnos* L. (Strychnae) and *Spigelia* L. (Spigeliae) (Leeuwenberg and Leenhouts 1980). However, in *Mitrasacme* one-nerved leaf venation is also known. In *S. helmsii* and *S. montana*, the heteromorphic calyx noted by Dunlop (1996c) may be a consequence of the presence of sepal-like bracts subtending the solitary flowers. Where the pedicel is very short, the bracts often completely enclose one pair of calyx lobes, which consequently remain more membranous and less well-developed than the exposed pair of calyx lobes. In material with longer pedicels, the calyx lobes are often more or less equal, as they often are in the more densely imbricate *S. novae-zelandiae* and *S. ciliata*. In *S. archeri*, interpretation of calyx and bract morphology proved problematic with the material at hand.

Corolla aestivation within *Schizacme* is variable. The phylogenies inferred in this study (Figs 1, 2) are consistent with a least two switches between imbricate (cochlear) and valvate corolla aestivation within *Schizacme*. In the remaining tribes of Loganiaceae (Antonieae, Spigeliae and Strychnae) corolla aestivation is exclusively valvate (Leeuwenberg and Leenhouts 1980). In Loganiaceae, corolla aestivation is valvate in *Adelphacme* K.L.Gibbons, B.J.Conn & M.J.Henwood, *Mitrasacme* and *Phyllangium* and imbricate (cochlear) in *Logania* R.Br. (Conn 1994, 1995). Within *Mitreola* L. and *Geniostoma* J.R.Forst. & G.Forst., corolla aestivation is also variable, being imbricate or contorted in *Geniostoma* (Conn 1980), and, in *Mitreola*, generally quincuncial, but valvate in the Madagascan *M. turgida* Jovet (Leeuwenberg 1974, Conn 1996). Thus, it appears that variable corolla aestivation is a feature not only of *Schizacme* but of Loganiaceae as a whole.

The phylogenies inferred in this study suggest *Schizacme* might have originated in New Zealand as a result of long distance dispersal of a common ancestor of *Schizacme* and *Phyllangium* from Australia to New Zealand. One or more westward dispersals from New Zealand to Australia would then explain the current geographical distribution of species of *Schizacme*. While eastward trans-Tasman dispersals predominate in the literature, supporting the hypothesis of a directional bias in long distance dispersals due to west wind drift at these latitudes, examples of westward dispersals are also proposed (Sanmartin and Ronquist 2004, Sanmartin et al. 2007). Other examples of putative westward trans-Tasman dispersals are proposed within *Gaultheria* L. (Bush et al. 2009), *Ranunculus* L. (Lockhart et al. 2001), *Asplenium hookerianum* (Perrie et al. 2010); *Veronica ciliolata* (Hook.f.) Cheeseman and *V. densifolia* (F.Muell.) F.Muell. (Meudt and Bayly 2008).

Taxonomy

Schizacme Dunlop, *Flora of Australia* 28: 314 (1996).

Type species: *Schizacme montana* (Hook.f. ex Benth.) Dunlop, *Flora of Australia* 28: 314–315 (1996).

Perennial subshrubs. **Branches** woody at base, nodose with residual leaf bases, minutely 4-winged or many-ridged. **Stipules** a membranous interpetiolar sheath. **Leaves** opposite, decussate, imbricate. **Flowers** solitary, terminal; subtended by paired, sepal-like or leaf-like bracts; perianth and androecium 4-merous. **Calyx** campanulate; lobes heteromorphic or \pm equal in size and shape. **Corolla** white or translucent; lobes valvate or imbricate (cochlear). **Stamens** inserted at mouth of corolla in sinuses between lobes; filaments very short; anthers apiculate (by extension of connective), very slightly exerted beyond corolla tube, dehiscence introrse. **Ovary** superior, 2-locular, distally winged. **Styles** 2, erect, connivent. **Fruiting calyx** persistent; lobes slightly larger than in flower. **Fruit** a capsule, persistent, coriaceous to woody, semi-apocarpous; distal (free) portion of carpels somewhat or very broadly divaricate, distally winged or with wings forming a sheath between the locules; styles persistent or withering somewhat in fruit. **Seeds** few, \pm elliptic.

A genus of five species of perennial subshrubs in Australia (Victoria and Tasmania) and New Zealand (South Island and Stewart Island).

Key to species of *Schizacme*

1. Leaves \pm petiolate, pliable, with margin thickened, if hyaline only narrowly and indistinctly so
 2. Pedicle glabrous, <1.3 mm long; calyx glabrous; styles 1.3–1.9 mm long; New Zealand *S. helmsii*
 - 2: Pedicle pilose or occasionally glabrescent, 2–35 mm long; calyx often pilose; lobes ciliate; styles \leq 1.2 mm long; Australia *S. montana*
- 1: Leaves sessile, rigid, with margin distinctly pale or hyaline or apex with a hyaline apiculum
 3. Leaf apex obtuse, midrib distinct; capsule wider than long; Australia *S. archeri*
 - 3: Leaf apex with a hyaline apiculum, midrib indistinct; capsule longer than wide; New Zealand

4. Leaves linear-oblong; if margin hyaline then narrowly so, glabrous; corolla lobes 0.6–1 mm long, 0.8–1.2 mm wide *S. novae-zelandiae*
- 4: Leaves oblong to obovate; margin broadly hyaline in distal half or for most of their length, often ciliate at base (occasionally glabrous or glabrescent); corolla lobes 1–1.4 mm long, 0.4–0.8 mm wide *S. ciliata*

Schizacme archeri (Hook.f.) Dunlop, *Flora of Australia* 28: 315 (1996).

Mitrasacme archeri Hook.f., *Botany of the Antarctic Voyage... Volume 3, Flora Tasmaniae* 2: 368 (1859).

Holotype: Tasmania: Western Mountains, *W. Archer s.n.*, without date (K883388, photograph!).

Illustration: Stones M, Curtis W, *Endemic Flora of Tasmania* 2, t. 38 (1969), as *M. archeri*.

Perennial cushion-forming subshrub to c. 5 cm high. **Leaves** sessile, rigid, oblong to narrowly obovate, 2.5–3.5(–3.8) mm long, 0.9–1.3 mm wide; base slightly tapering; margin hyaline in distal half or for most of length, ciliate at base; apex obtuse; midrib distinct, venation other not visible. **Bracts** difficult to distinguish from leaves, so quantitative measurements not provided; margin minutely hyaline, ciliolate at base; apex obtuse or rounded. **Pedicels** up to 0.5 mm long (in flower), hence flowers subsessile, 0.2–2 mm long (in fruit), glabrous. **Calyx** tube 0.2–0.6 mm long, glabrous; lobes triangular or oblong, heteromorphic, 1.4–1.8 mm long, 0.7–1 mm wide, glabrous or ciliolate at base; apex ± acute. **Corolla** campanulate, glabrous; tube 1.5–3 mm long; lobes acute, 1–2 mm long, 1–1.2 mm wide, imbricate (cochlear). **Styles** c. 0.75 mm long. **Capsule** laterally flattened (appearing cuneiform in lateral view), 2–2.3 mm long, 3–4.5(–5.5) mm wide; locules elongate, oblique; free (distal) portion of carpels very broadly divaricate, with wings forming a sheath between them; wings bilobed, labiate; styles persistent or withering somewhat in fruit. **Seeds** 2 or 3 per locule, c. 0.75 mm long, c. 0.50 mm wide. Fig. 3a.

Distribution and habitat: Endemic to Tasmania, Australia, where it is widely distributed in the west of the state, south from Cradle Mountain, Central Highlands. Known to occur in mosaic cushion heath (Gibson and Hope 1986), but also collected on bare ground. *Schizacme archeri* is classified as a compact cushion (Gibson and Hope 1986), according to the system of Rauh (1939).

Conservation status: Not threatened.

Notes: The bracts of this species are difficult to distinguish from the leaves in herbarium material. Therefore, the characteristics of the bracts could not be measured with any confidence. Some fruiting material has the appearance of a calyx in two series, as described by Dunlop (1996c). The outer, larger whorl is perpendicular to the bracts in other species of *Schizacme* and, therefore, does not appear homologous. In flowering material the calyx is clearly 4-lobed with a short tube. Further study, preferably of fresh material, is required to gain a better understanding of calyx and bract development in this species.

It is not known if the Archer collection cited below (NSW229370), without location, number or date, represents type material.

Selected material examined (c. 41 specimens): AU STRALIA: TASMANIA: WEST COAST: Head of Melaleuca Creek, New Harbour, *C. Davis ex F.A. Rodway herb. No. 6379*, Jan 1938 (NSW); Mount Owen, *W.V. Fitzgerald s.n.*, Mar 1894 (NSW229367); Mount Humboldt, *L.R. Rodway s.n.*, without date (NSW229765); Frenchmans Cap, just below summit, *A.M. Buchanan 12686*, 6 Dec 1992 (HO); Great Dome, Denison Range, *A.M. Buchanan 12993*, 30 Jan 1993 (HO); SOUTH WEST: Mount La Perouse, *F.A. Rodway herb. No. 6381*, Dec 1898 (NSW); Adamsons Peak, *L.R. Rodway s.n.*, Dec 1897 (NSW229368); Low hills behind Coffin Bay, Port Davey, *A.M. Buchanan 9286*, 5 Jan 1987 (HO); Mt Pollux, *J.B. Kirkpatrick s.n.* 13 Feb 1987 (HO511635); Elliot Hill, *A. Moscal 11795*, 17 Jan 1986 (HO); Mt Gaffney, *A. Moscal 11666*, 14 Jan 1986 (HO); 3 km south-east of Federation Peak, *A. Moscal 2104*, 7 Mar 1983 (HO); CENTRAL HIGHLANDS: Cradle Mountain, *F.A. Rodway herb. No. 6382*, Dec 1915 (NSW); Cradle Mountain, *G. Weindorfer s.n.*, Jan 1915 (NSW229363); Shannon Lagoon, Great Lake, *A.V. Giblin s.n.*, c.1900s (HO22539); North ridge of Mt Gell, *P. Collier 1889*, 15 Nov 1986 (HO); Top of Mt Ossa, *J.B. Davies 75*, 26 Nov 1989 (HO); Mountains of Jupiter, *A.M. Buchanan 12741*, 31 Dec 1992 (HO); Eldon Bluff, summit of plateau, *A.M. Buchanan 9997*, 5 Feb 1987 (HO); MOUNT FIELD: Mount Field National Park: summit of Mount Field West, *R. Melville 2323* (NSW, MEL), *J.H. Willis, W. Curtis and D. Paton s.n.*, 12 Dec 1952 (NSW229372); Mount Field East, *F.J.H. Mueller s.n.*, without date (NSW229371), “moorland mosaic track”, left-hand side of Dobson Road towards Lake Dobson, *M.J. Henwood 865*, 11 Feb 2010 (NSW, SYD); K. Col, Mt Field National Park, *W.M. Curtis s.n.*, 7 Jan 1948 (HO327941); LOCALITY UNKNOWN: *W.H. Archer s.n.*, without date (NSW229370).

Schizacme montana (Hook.f. ex Benth.) Dunlop, *Flora of Australia* 28: 314–315 (1996). *Mitrasacme montana* Hook.f. ex Benth., *Journal of the Proceedings of the Linnean Society Botany* 1: 93–94 (1857).

Type citation: ‘*Hab.* Ad montes Wellington et Black Bluff, Tasmania (*Gunn*).’

Lectotype (designated here): Tasmania: South East: Mt Wellington, ‘V. D. Land’ [Van Diemen’s Land], R.C. Gunn s.n. [species number 2018 (Buchanan 1988)], without date (K883384, photograph!); probable isolectotype: HO22547 (photograph!).

Residual syntype: Tasmania: Central Highlands: Black Bluff Mountain, Feb. 1837, R.C. Gunn s.n. [species number 2018] (K883385, photograph!).

Illustrations: Brooks V, in Hooker JD, *Botany of the Antarctic Voyage...Volume 3, Flora Tasmaniae* 1, Pl. 88 (1857), as *M. montana*; Brosch T, in Walsh NG, Entwistle TJ (eds) *Flora of Victoria* 4: 308, Fig. 60d (1999), as *S. montana* var. *montana*.

Perennial subshrub to 8 cm high. **Leaves** ± petiolate, pliable; petiole winged, not readily distinguished from lamina base; lamina obovate, 5–12 mm long (including petiole), 1.5–5 mm wide; base attenuate; margin thickened or minutely hyaline, glabrous or occasionally ciliate; apex obtuse or rounded; midrib distinct, penninerved. **Bracts** sepal-like or leaf like, narrower than leaves, oblong (in flower), 3–8 mm long, 1–2 mm wide, becoming obovate (in fruit), 3.5–9 mm long, 1–5 mm wide, glabrous; apex rounded. **Pedicels** 2–6 (–14) mm long (in flower), 2–35 mm long (in fruit), pilose or occasionally glabrescent (in fruit). **Calyx** tube difficult to distinguish from receptacle, 0.1–0.5 mm long, pilose or occasionally glabrescent; lobes slightly heteromorphic (with pair of lobes adjacent to bracts smaller and more membranous) or ± equal, ovate or elliptic, 1.8–4 mm long, 1.3–2.3 mm wide, ciliate, often pilose or papillose on abaxial surface; apex acute or obtuse. **Corolla** tubular, with few to many oblong to obovate spoon-like trichomes in sinuses, occasionally also with linear-triangular trichomes; tube 2–2.5 long; lobes acute, triangular, 0.8–1.3 mm long, 1–1.3 mm wide, valvate. **Styles** 1–1.2 mm long. **Capsule** laterally flattened (appearing cuneiform in lateral view); 2–4 mm long, 3.5–8 mm wide; locules elongate, oblique; free (distal) portion of carpels very broadly divaricate with wings forming a sheath between them; wings bilobed, labiate; styles persistent or withering somewhat in fruit. **Seeds** 2 to 4 per locule, 0.7–0.75 mm long, 0.4–0.5 mm wide. Figs 3b, 6.

Distribution and habitat: Endemic to Australia (Victoria and Tasmania). In Victoria, this species is restricted to Mount Baw Baw. In Tasmania, *S. montana* is widespread in the west of the state, extending east to Mount Wellington, near Hobart. Often occurring in association with *Gymnoschoenus sphaerocephalus* (R.Br.) Hook.f. (buttongrass) in poorly drained sites. Although this species is commonly described as mat-forming, further field observations are required to determine whether *S. montana* also forms cushions in some habitats.

Conservation status: Not threatened in Tasmania. The population at Mt Baw Baw, Victoria is listed as rare (Victorian Department of Sustainability and Environment 2005).

Notes: The type sheet (Fig. 6) is a mixed collection, containing not only the Mount Wellington (K883384) and Black Bluff (K88385) collections mentioned in the protologue, but also two other collections, apparently sent to Hooker by Ferdinand Mueller. These are a Mueller 1861 collection from Mt Baw Baw (K883386) and an Oldfield collection, without date (K883387). Below these collections a description, citing the Oldfield collection, is annotated in Hooker’s hand with the manuscript name *Mitrasacme montana* ‘f. Hook.’ var. *scapigera*, following which the label has been signed by Ferdinand Mueller. It is unclear to whom the authority for the informal varietal epithet belongs. Although pedicel length is variable in *S. montana*, the variation does not appear to be of taxonomic significance. *Schizacme montana* exhibits a greater range of morphological variation, across a number of characters, than other species of *Schizacme*. It is likely this variation reflects the broader ecological and altitudinal range of *S. montana* compared with other species.

Selected material examined (48 specimens): AUSTRALIA: VICTORIA: EASTERN HIGHLANDS: Mount Baw Baw National Park: Mount Baw Baw, *Mueller s.n.*, 1861 (K883386 – photograph!); Currawong Flat, c. 1.1 km NE from Mount Baw Baw summit, *N.G. Walsh 681*, 5 Dec 1981 (MEL); *J.H. Willis s.n.*, 10 Dec 1963 (MEL695895A). TASMANIA: WEST COAST: Gordon River, Vale of Rasselas, *A.M. Buchanan 13060*, 1 Feb 1993 (HO); Zeehan, *W.V. Fitzgerald ex herb. Burbury s.n.*, c. 18902 (HO123057); SOUTH WEST: SE ridge of the Lawson Range, *A.M. Buchanan 8105*, 25 Jan 1986 (HO); Jubilee Range, *A. Moscal 9241*, 13 Jan 1985 (HO); Mount Field National Park: Golden Stairs, above Lake Dobson, *J.M.B. Smith 296*, 6 Jan 1978 (HO); besides Lake Newdegate, *J.M.B. Smith 437*, 18 Jan 1978 (HO); CENTRAL HIGHLANDS: 2 km W of Granite Tor, *A.M. Buchanan 5490*, 22 Jan 1985 (HO); 1.5 km E of Wylds Craig, *A. Moscal 10210*, 17 Mar 1985 (HO); MOUNT WELLINGTON: Mt Wellington, *W.M. Curtis s.n.*, 21 Jan 1945 (HO411532); 23 Jan 1945 (HO327939); *L. Rodway s.n.*, Dec 1897 (NSW229360); summit on zig-zag track, *M.J. Henwood 937*, 19 Jun 2012 (NSW, SYD).

Schizacme helmsii (Kirk) K.L.Gibbons, *comb. et stat. nov.*

Mitrasacme montana Hook.f. ex Benth. var. *helmsii* Kirk, *Transactions and Proceedings of the New Zealand Institute* 22: 445, t. 32 (1890).

Type citation: ‘*Hab.* South Island–Paparoa Ranges, Westland; 3,000ft. *R. Helms*.’

Lectotype (designated here): New Zealand, South Island, Paparoa Ranges, Westland; 3000 ft; *R. Helms s.n.*, Mar 1887 (WELT-SP011236); possible isolectotypes: WELT-SP011228 (photograph!), WELT-SP055982 (photograph!).

Illustration: Kirk T, *Transactions and Proceedings of the New Zealand Institute* 22: t. 32 (1890).

Perennial subshrub to 5 cm high. **Leaves** ± petiolate, pliable, glabrous or occasionally with a few scattered hairs on adaxial surface near base; petiole winged, not readily distinguished from lamina base; lamina obovate, 2.5–4.5 (–6) mm long (including petiole), 1.4–2.2 mm wide; base attenuate; margin thickened or minutely hyaline, glabrous; apex obtuse or rounded; midrib distinct, penninerved. **Bracts** sepal-like, narrower than leaves, oblong (in flower), 2.2–3.5 mm long, 1–1.2 mm wide, becoming narrowly obovate to obovate (in fruit), 3.7–4.4 mm long, 1.1–1.5 mm wide, glabrous; apex obtuse or rounded. **Pedicels** up to 0.5 mm long (in flower), hence flowers subsessile; 0.2–1.3 mm long (in fruit), glabrous. **Calyx** glabrous; tube 0.2–0.7 mm long; lobes slightly heteromorphic (with pair of lobes adjacent to bracts smaller and more membranous) or ± equal, narrowly triangular to narrowly ovate; larger pair (1.7–) 2–2.7 mm long, 0.7–1.2 mm wide; apex acute or obtuse. **Corolla** tubular, with oblong to obovate spoon-like trichomes in sinuses (trichomes c. 85–200 µm long, 70–100 µm wide); tube 2.2–3.5 (–4.4) mm long; lobes acute to obtuse, 0.7–1.5 mm long, valvate. **Styles** 1.3–1.9 mm long. **Capsule** laterally flattened (appearing cuneiform in lateral view); 2.5–2.9 mm long, 3.7–5 mm wide; locules elongate, oblique; free (distal) portion of carpels very broadly divaricate, with wings forming a sheath between them; wings bilobed, labiate; styles persistent or withering somewhat in fruit, generally incurved. **Seed** number not seen, 0.6–0.8 mm long, 0.4–0.6 mm wide. Figs 4, 5.

Etymology: The species epithet is in honour of the collector, Richard Helms, botanist and zoologist, 1842–1914 (Chisholm 1972).

Distribution and habitat: Endemic to the South Island of New Zealand. This species is known only from the Paparoa Range, and Denniston and Stockton Plateaux, Western Nelson, occurring in wet heath communities (Wardle 1991). Although this species is commonly described as mat-forming, further field observations are required to determine whether *S. helmsii* also forms cushions in some habitats.

Conservation status: Listed as Threatened – Nationally Endangered, qualified DP [Data Poor], RR [Range Restricted], Sp [Sparse] under the New Zealand Threat Classification System (de Lange 2013). Although naturally uncommon, the near restriction of this endemic species to coal seam measures of the Denniston and Stockton Plateaux means *S. helmsii* is threatened by active and potential coal mining in these regions (New Zealand Plant Conservation Network 2014).

Notes: Allan (1961 p. 547) cites the type as “W. *R. Helms*, 1885”. Allan (1961 p. 547) cites the type as “W. *R. Helms*, 1885”, but this earlier collection from New Zealand, South Island, Paparoa Ranges, Westland; 2,800 ft; *R. Helms s.n.*, 1885, (WELT-SP011235) differs from the protologue in the stated altitude. For this reason, although it is likely to be original material, we have ruled it out as candidate for lectotypification. At WELT, there are three sheets of collections by Richard Helms at 3,000ft. in the Paparoa Ranges and we have chosen the sheet with the best representation of specimens and a label with a diagnostic statement in Kirk’s hand (WELT-SP011236) as lectotype.

Schizacme helmsii differs from *S. montana* by the characters listed in Table 1.

Material examined: NEW ZEALAND: SOUTH ISLAND: WESTLAND: Paparoa Ranges, 2800 ft; *R. Helms s.n.*, 1885 (WELT-SP011235); Mount Watson, Paparoa Range, c. 3000 ft, *L.B. Moore & J. Clarke s.n.*, 14 Jan 1967 (CHR174709); saddle between Mt Davey and Sewell Peak, 880m, *P. Wardle* ‘No.3’, 19 Apr 1987 (CHR437837); Mt Davy, Paparoa Range, 2800 ft, *W.R.B. Oliver s.n.*, 26 Feb 1949 (WELT-SP038767); Track between Mount Davey and Sewell Peak, *D. Glenny* 11640, 19 Nov 2012 (CHR); Grey County, *P.G. Morgan s.n.*, without date (WELT-SP011234); lower slopes Mt. Rochford, Denniston Plateau, 600m, *M.J.A. Simpson* 7844, 9 Apr 1976, (CHR); Denniston Plateau, 2150 ft, *A.P. Druce s.n.*, Jan 1981 (CHR389239); Mt Frederick, 1080m, *A.P. Druce s.n.*, Jan 1987 (CHR395821).

Schizacme novae-zelandiae (Hook.f.) K.L.Gibbons, comb. nov.

Mitrasacme novae-zelandiae Hook.f., *Handbook of the New Zealand Flora* 2:737 (1867).

Holotype: New Zealand, South Island, Dusky Bay, on the hills, alt. 3500ft, *Hector & J. Buchanan* ‘No. 65’, 1863, (K883460, photograph!).

Perennial cushion-forming subshrub to 3 cm high. **Leaves** sessile, rigid, densely imbricate, linear-oblong, concavo-convex, 2.7–4 mm long (excluding apiculum), 0.5–0.9 mm wide, glabrous; margins minutely hyaline in distal half or for most their length; apex with hyaline apiculum 0.1–0.5 mm long; midrib indistinct, other venation not visible. **Bracts** difficult to distinguish from leaves, linear to oblong, 2.2–2.7 mm long, 0.5–0.7 mm wide, glabrous; with hyaline apiculum 0.2–0.3 mm long. **Pedicels** < 0.1 mm, glabrous.



Fig. 4. *Schizacme helmsii*. **a, b.** details of flowers and leaves; **c.** gynoecium, showing wings; **d.** capsule and leaves (*D. Glenn* 11640). Images: P.J. Heenan. Scale bar: **a, b, d** = 2 mm; **c** = 1 mm.

Calyx glabrous; tube 0.4–0.6 mm long; lobes narrowly triangular to triangular, with one pair slightly larger or lobes more or less equal, 1–1.9 mm long, 0.4–1 mm wide; with hyaline apiculum 0.1–0.2 mm long. **Corolla** campanulate, glabrous; tube 1.7–3 mm long; lobes obtuse, \pm acuminate, 0.6–1 mm long, 0.8–1.2 mm wide, imbricate (cochlear). **Styles** 0.4–0.5 mm long. **Capsule** slightly laterally flattened, 2.2–3.4 mm long, 1.9–2.5 mm wide; locules \pm globular; wings distal, navicular. **Seed** number not seen, 0.6–0.7 mm long, 0.4–0.5 mm wide. Figs 5, 7, 8.

Distribution and habitat: Endemic to the South Island of New Zealand, from North West Nelson to Fiordland. Occurring in *Chionochloa* Zotov tussock grasslands in wet heath and mountain heath communities, in mosaic cushions dominated by *Donatia novae-zelandiae* Hook.f. (Wardle 1991). Flowers November to January, fruit January.

Conservation status: Not threatened (de Lange 2013)

Notes: In the mixed Cockayne collection (Hills' Peak, 1360ft, *L. Cockayne* 5656, without date, WELT-SP011225) referred to by Cheeseman (1906 p. 442), the narrower-leaved material, is consistent with the type material.

Other material examined: NEW ZEALAND: SOUTH ISLAND: WESTERN NELSON: Mt. Goul, *J. Ballin s.n.*, Dec 1963 (CHR147537); Mt Goul, *W.B. Brockie s.n.*, without date (CHR 259057); Perry Saddle, 2900 ft, *A.P. Druce s.n.*, Jan 1973 (CHR222853); Above Lake Cobb, head of Cobb Valley, 4000 ft, *A.P. Druce s.n.*, Jan 1970 (CHR252169); Gunner Downs, 3800 ft, *A.P. Druce s.n.*, Nov 1979 (CHR363492); Zetland Basin, Allen Range, 4000 ft, *A.P. Druce s.n.*, Jan 1981 (CHR387106). WESTLAND: Paparoa Range, Mount Rajah, 2700 ft, *L.B. Moore & J. Clarke s.n.*, 14 Jan 1967 (CHR174596); Paparoa Range, near Mt. Rajah, 2700 ft, *L.B. Moore, J. Clarke & I. Robins s.n.*, 18 Dec 1965 (CHR168043); Lake Dime on Mataketake Range, 3800 ft, *P. Wardle & R.P. Buxton s.n.*, 2 Dec 1991 (CHR476872A, B); CANTERBURY: Arthur's Pass, *L.B. Moore s.n.*, 2 Dec 1973 (CHR243861); Arthur's Pass National Park, Minchin Pass Bivouac, *D. Glenny 11049*, 23 Nov 2010 (CHR); Arthur's Pass, Hill's Peak, 1360ft, *L. Cockayne* 5656, without date (WELT) (mixed collection with *S. ciliata*).

Schizacme ciliata K.L.Gibbons, *sp. nov.*

Holotype: New Zealand, Stewart Island, [Port] Pegasus, *B.C. Aston s.n.*, Nov 1907 (WELT-SP055737).

Diagnosis: Closely allied to *S. novae-zelandiae* but differs in leaves being oblong to obovate, 0.8–1.4 mm wide, (linear-oblong, 0.5–0.9 mm wide in *S. novae-zelandiae*) with margin more pronounced hyaline and usually with ciliate hairs at base (*S. novae-zelandiae* always glabrous); corolla tube shorter (c. 1.2 mm long cf.

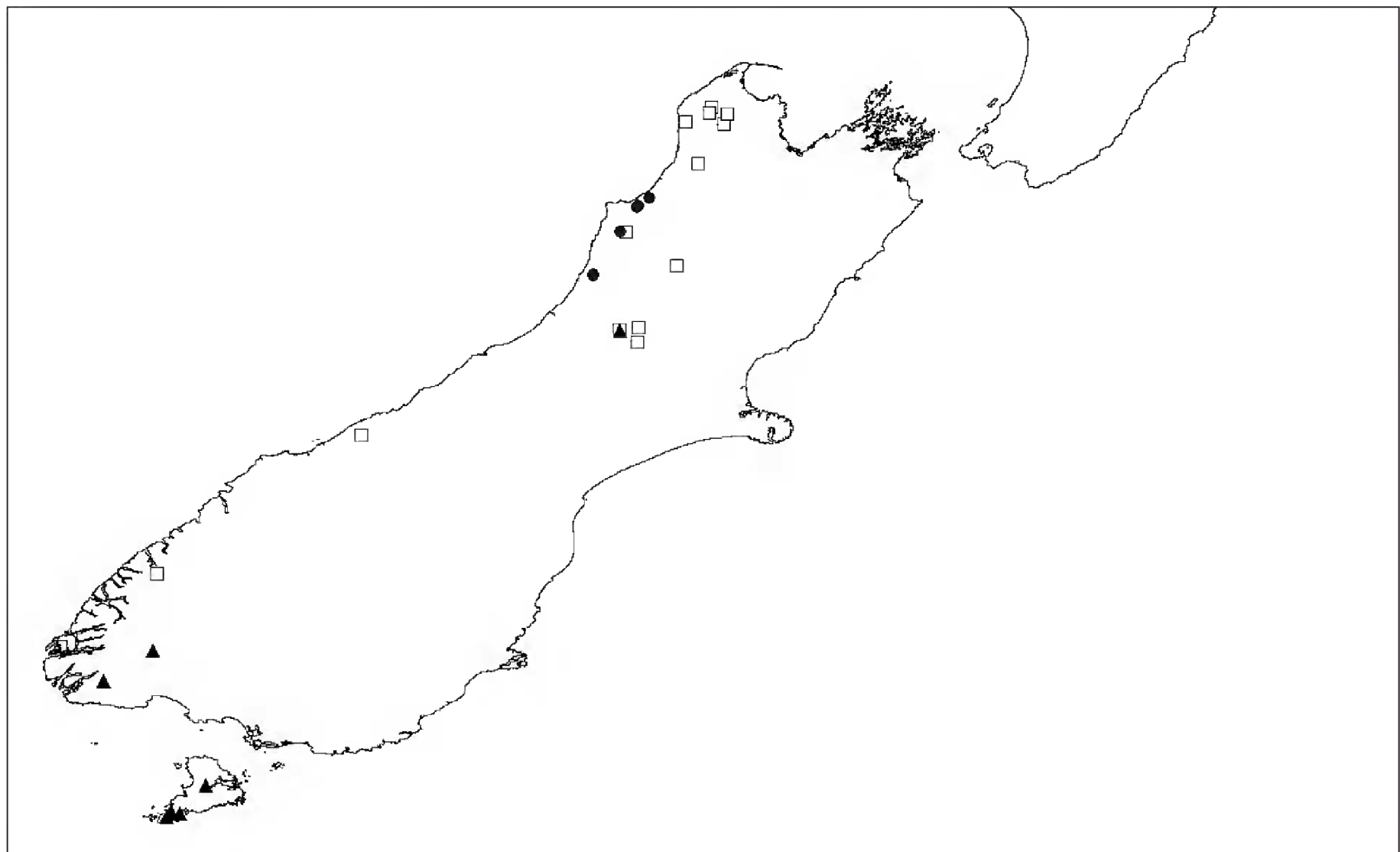


Fig. 5. Distribution of *Schizacme* in New Zealand (South Island and Stewart Island). ● *S. helmsii*, □ *S. novae-zelandiae*, ▲ *S. ciliata*.

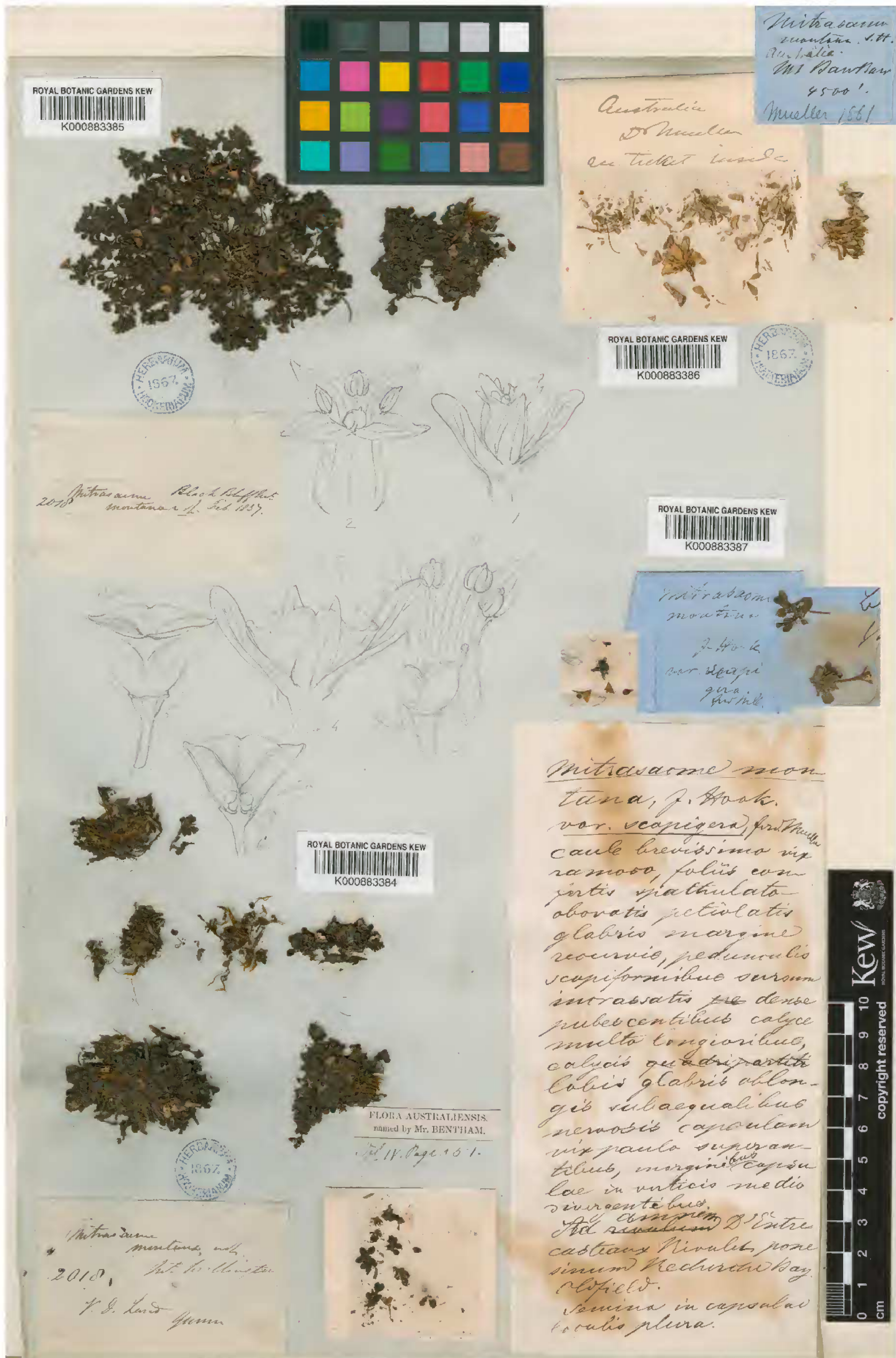


Fig. 6. Type sheet of *Schizacme montana* as held at K. Lectotype (lower left); residual syntype (upper left). Note: specimens in open envelopes (upper and centre right) are not part of type. Image: <http://specimens.kew.org/herbarium/K000883384>

S. novae-zelandiae 1.7–3 mm long) and corolla lobes longer and narrower (1–1.4 mm long, 0.4–0.8 mm wide cf. *S. novae-zelandiae* 0.6–1 mm long, 0.8–1.2 mm wide).

Perennial cushion-forming subshrub to 3 cm high. **Leaves** sessile, rigid, densely imbricate, oblong to obovate, 2–4 mm long, 0.8–1.4 mm wide; margins hyaline in distal half or for most their length, with 1–10 pairs of ciliate hairs at base, or occasionally glabrous or glabrescent; apex with hyaline apiculum 0.1–0.8 (–1.4) mm long; midrib indistinct, other venation not visible. **Bracts** difficult to distinguish from leaves, oblong to obovate, c. 3.5 mm long, c. 0.8–1 mm wide, ciliate; with hyaline apiculum c. 0.3 mm long. **Pedicels** < 0.1 mm, glabrous. **Calyx** glabrous; tube 0.3–0.5 mm long; lobes linear-oblong, more or less equal, 1.2–2.2 mm long, 0.5–0.8 mm wide; with hyaline apiculum 0.1–0.2 mm long. **Corolla** tubular, glabrous; tube c. 1.2 mm long; lobes acute, c. 1–1.4 mm long, c. 0.4–0.8 mm wide, aestivation not seen. **Styles** c. 0.6 mm long. **Capsule** slightly laterally flattened, 3.2–3.6 mm long, 1.5–2 mm wide; locules \pm globular; wings distal, navicular. **Seed** number not seen, c. 0.75 mm long, c. 0.40 mm wide. Figs 5, 8.

Etymology: The specific epithet refers to the ciliate hairs at the base of the leaves.

Distribution and habitat: Endemic to New Zealand: Stewart Island and South Island. In the south Island, known from Fiordland and from one collection from Hill’s Peak, Arthur’s Pass, Canterbury (a mixed collection



Fig. 7. *Schizacme novae-zelandiae*: **a.** Showing leaves and flower; **b.** Open flowers showing staminal filaments, anthers, and stigmas; **c.** photograph of habitat, with flowering species growing with *Donatia novae-zelandiae* (right) (all D. Glenny 11049). Images: D. Glenny. Scale bar: **a, c** = 4 mm; **b** = 1 mm.

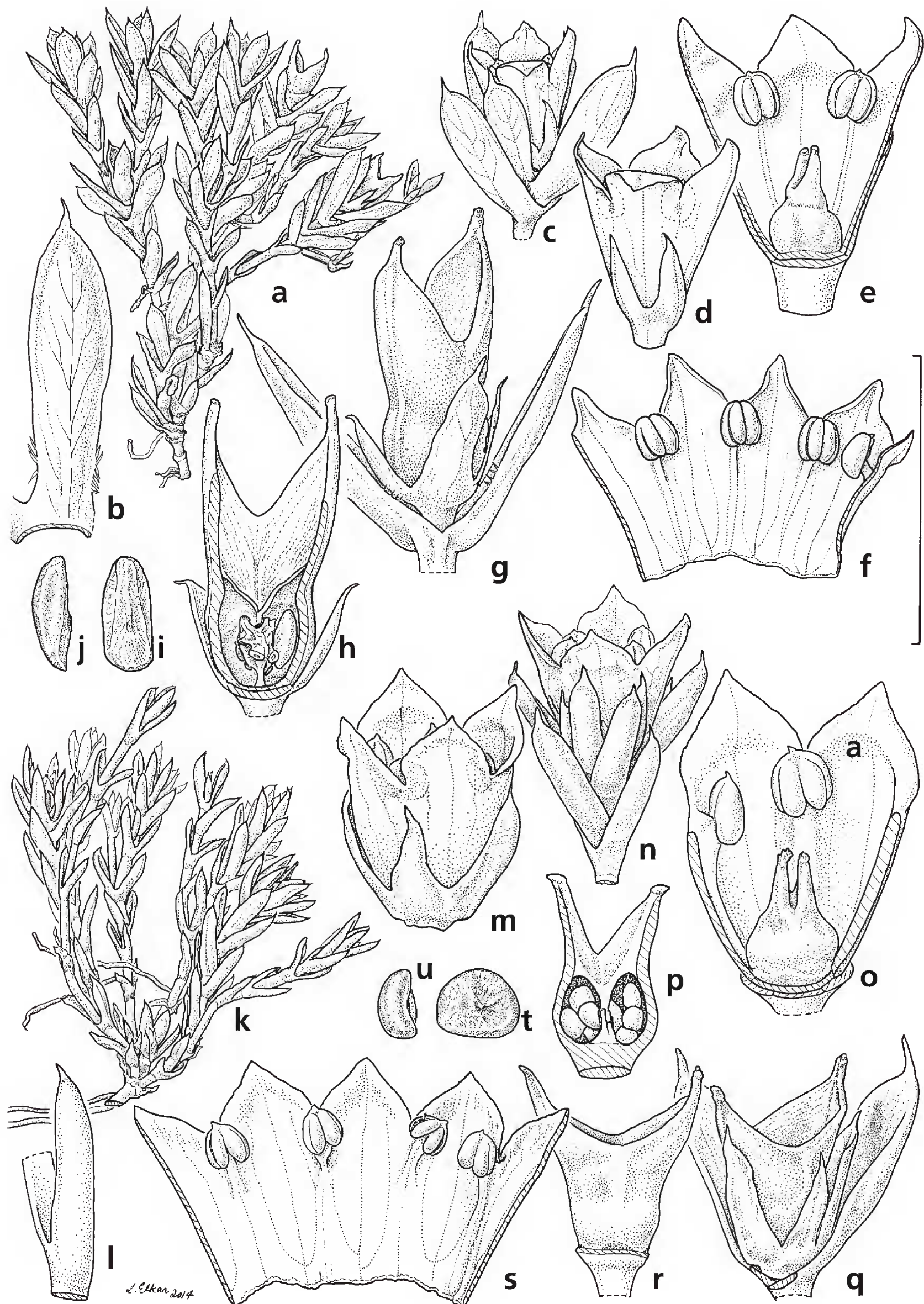


Fig. 8. Illustration of *Schizacme ciliata* and *S. novae-zelandiae*. *Schizacme ciliata*, **a.** habit; **b.** leaf; **c.** flower *in situ*; **d.** flower, side view; **e.** longitudinal section (l.s.) of flower showing carpel; **f.** corolla open; **g.** fruit, showing calyx; **h.** fruit, l.s. with mature seeds *in situ*; **i, j.** seed. **a, b, g–j.** from *T. Kirk s.n.*, 22 Jan 1887 (WELT-SP011229); **c–f.** from *B.C. Aston s.n.*, Nov 1907 (WELT-SP055737). *Schizacme novae-zelandiae*, **k.** habit; **l.** leaf; **m.** flower, side view; **n.** flower *in situ*; **o.** flower, l.s. showing carpel; **p.** immature fruit, showing ovules; **q.** fruit *in situ* showing calyx; **r.** fruit, side view; **s.** corolla open; **t, u.** seed. **k, l, p, s.** from *L.B. Moore, J. Clarke & I. Robins s.n.*, 18 Dec 1965 (CHR168043); **m, n, o.** from *P. Wardle & R.P. Buxton s.n.*, 2 Dec 1991 (CHR476872A); **q, r, t, u.** from *A.P. Druce s.n.*, Jan 1973 (CHR222853). Scale bar: **a, k** = 15 mm; **b, d, f–h, l, m, p–s** = 4 mm; **c, n** = 6 mm; **e, o** = 3 mm; **i, j, t, u** = 2 mm. Illustration: Lesley Elkan.

with *S. novae-zelandiae*). In Stewart Island, occurring on very wet upland peat with *Donatia novae-zelandiae* and *Oreobolus pectinatus* Hook.f. (Wardle 1991).

Conservation status: This new species is imperfectly known and has not been recently collected. Further field observations are needed to assess the status of previously recorded populations and to better characterise the habitat preferences of *S. ciliata*. In the meantime, an interim listing of At Risk – Naturally Uncommon, qualified DP [Data Poor] and RR [Range Restricted] would be appropriate, because Wardle (1999) suggests that at least Stewart Island populations are confined to very wet peat habitats. Recorded populations presently occur on protected land.

Notes: Only one flowering specimen (holotype, collected in November) was available for study. Fruiting specimens were collected in January or without date (cited below). Further field studies are required to determine whether flowering time is earlier than that of *S. novae-zelandiae*.

Some collections from Fiordland might represent intermediates between *S. novae-zelandiae* and *S. ciliata*.

Other material examined: NEW ZEALAND: SOUTH ISLAND: CANTERBURY: Arthur's Pass, Hills' Peak, 1360ft, L. Cockayne 5656, without date (WELT) (mixed collection with *S. novae-zelandiae*). RAKIURA: Stewart Island: Near trig19061 north of Smith's Lookout, 215 m, H.D. Wilson 210, 8 Apr 1978, (CHR – sterile); Rakaiahua [Rakeahua], T. Kirk s.n., without date (WELT-SP011226); Highest point of Smith's Lookout, T. Kirk s.n., 22 Jan 1887 (WELT-SP011229); Smith's Lookout, T. Kirk s.n., 22 Jan 1887, (WELT-SP055735); Fraser Peaks, T. Kirk s.n., without date (WELT-SP011233); Fraser Peaks, T. Kirk s.n., 24 Jan 1887 (WELT-SP055736).

Excluded names in *Mitrasacme* in New Zealand

Accepted and excluded names in Australian *Mitrasacme* are listed in Dunlop (1996a). There are now no remaining accepted names in *Mitrasacme* in New Zealand.

Mitrasacme hookeri Buchanan, *Transactions and Proceedings of the New Zealand Institute* 14: 348, Pl. 29, fig. 1 (1881 [1882]).

= *Veronica hookeri* (Buchanan) Garn.-Jones, *Taxon* 56: 577 (2007). *Logania ciliolata* Hook.f., *Handbook of the New Zealand Flora* 737 (1867). *Hebe ciliolata* (Hook.f.) Cockayne & Allan, *Transactions and Proceedings of the New Zealand Institute* 57: 39 (1926). *Leonohebe ciliolata* (Hook.f.) Heads, *Botanical Society of Otago Newsletter* 5: 5 (1987). *Veronica gilliesiana* Kirk, *Transactions and Proceedings of the New Zealand Institute* 28: 519 (1896). *Hebe gilliesiana* (Kirk) J.T.Wall, *New Flora and Silva* 11:135 (1939).

Mitrasacme petriei Buchanan, *Transactions and Proceedings of the New Zealand Institute* 14: 349, Pl. 30, fig. 1 (1881 [1882]).

= *Veronica petriei* (Buchanan) Kirk, *Transactions and Proceedings of the New Zealand Institute* 28: 517 (1896). *Hebe petriei* (Buchanan) Cockayne & Allan, *Transactions and Proceedings of the New Zealand Institute* 57: 42 (1926). *Leonohebe petriei* (Buchanan) Heads, *Botanical Society of Otago Newsletter* 5: 6 (1987).

Mitrasacme cheesemanii Buchanan, *Transactions and Proceedings of the New Zealand Institute* 14: 348, Pl. 29, fig. 2 (1881 [1882]).

= *Veronica quadrifaria* Kirk, *Transactions and Proceedings of the New Zealand Institute* 28: 521 (1896). *Hebe cheesemanii* (Buchanan) Cockayne & Allan, *Transactions and Proceedings of the New Zealand Institute* 57: 39 (1926). *Leonohebe cheesemanii* (Buchanan) Heads, *Botanical Society of Otago Newsletter* 5: 5 (1987).

Informal names in *Mitrasacme* in New Zealand

Allan (1961) p. 547 makes note of a specimen held at WELT labelled by Petrie as "*M. hydrophila* sp. nov. inedit". This specimen has been identified as *Coprosma atropurpurea* (Cockayne & Allan) L.B.Moore.

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We thank Marco Duretto (then HO) and Peter Heenan (CHR) for early discussions about *Schizacme*. David Glenny (CHR), Russell Barrett and Matt Barrett (both KPBG) generously provided material for DNA extraction. David Glenny and Peter Heenan also provided exquisite images of *S. novae-zelandiae*. Very special thanks go to Lesley Elkan (NSW) for her superb illustrations. Peter de Lange (Department of Conservation, Wellington) provided valuable advice on the current threat classification of *S. helmsii* and an appropriate interim threat

classification for *S. ciliata*. Peter Wilson (NSW) provided advice on nomenclature and typification. We thank the curators of CHR, DNA, HO, K, NSW and WELT for their hospitality and for access to their collections. Two referees are thanked for their thoughtful comments on the manuscript, which have greatly improved this paper.

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Appendix 1. Accessions and Genbank numbers for the nucleotide sequences included in the phylogenetic analyses.

Genbank numbers for accessions sequenced for this study are shown in bold. All other accessions were sequenced for Gibbons et al. (2012).

Locations: AUS=Australia. NZ=New Zealand. Within Australia, NSW = New South Wales, NT = Northern Territory, Tas. = Tasmania, SA = South Australia, Qld. = Queensland, WA = Western Australia

Taxa	Locality	Voucher	GenBank accession petD	ETS
Adelphacme				
<i>A. minima</i> (B.J.Conn) K.L.Gibbons, B.J.Conn & M.J.Henwood	NE of Walpole, WA, AUS	AR Annels & R Hearn s.n., NSW366874	JX046121	JX029168
Mitrasacme				
Subgen. Mitrasacme				
<i>M. brachystemonea</i> Domin	S of Musgrave, Cape York Peninsula, Qld, AUS	KL Gibbons 99, NSW	JX046108	JX029162
<i>M. glaucescens</i> Dunlop	Kakadu National Park, NT, AUS	KL Gibbons 83, NSW	JX046116	JX029165
<i>M. latiflora</i> S.Moore	Pine Creek, NT, AUS	KL Gibbons 85, NSW	JX046112	JX029160
<i>M. multicaulis</i> R.Br.	Howard Springs, NT, AUS	KL Gibbons 61, NSW	JX046117	JX029155
<i>M. nudicaulis</i> Reinw. ex Blume var. <i>nudicaulis</i>	Edith Falls, NT, AUS	KL Gibbons 54, NSW	JX046118	JX029164
<i>M. oasena</i> Dunlop	Gorge Creek, Atherton Tablelands, Qld, AUS	KL Gibbons 90, NSW	JX046115	JX029156
<i>M. phascoides</i> R.Br.	Lakefield National Park, Qld, AUS	KL Gibbons 108, NSW	JX046114	JX029161
<i>M. polymorpha</i> R.Br.	Fitzroy Falls, NSW, AUS	KL Gibbons 47, NSW	JX046110	JX029158
<i>M. scritchicola</i> Dunlop	Kakadu National Park, NT, AUS	KL Gibbons 80, NSW	JX046109	JX029159
<i>M. serpyllifolia</i> R.Br.	Lawson, NSW, AUS	KL Gibbons 50, NSW	JX046111	JX029157
<i>M. stellata</i> R.Br.	Bamboo Range, Cape York Peninsula, Qld, AUS	KL Gibbons 102, NSW	JX046107	JX029163
<i>M. subvolubilis</i> F.Muell.	Near Berry Springs, NT, AUS	KL Gibbons 71, NSW	JX046113	JX029154
Subgen. Schizogyne				
<i>M. secedens</i> Dunlop	Bullo River Station, NT, AUS	ID Cowie 12116, DNA, D0190868	KP100458	KP100465
Subgen. Plecocalyx				
<i>M. foliosa</i> C.A.Gardiner	30.5km SSW of (new) Theda Station Homestead, North Kimberley, WA, AUS	MD Barrett 3087, PERTH	KP100457	KP100464
<i>M. laxiceps</i> Dunlop	Theda Station, south side of Morgan River, south of new homestead, North Kimberley, WA, AUS	RL Barrett 6932, PERTH	KP100456	KP100463
Phyllangium				
<i>P. paradoxum</i> (R.Br.) Dunlop	Kings Park, WA, AUS	RL Barrett s.n. 17/10/2010, NSW888263	JX046119	JX029166
<i>P. sulcatum</i> Dunlop	Wogerlin Rock, 18.5 km N of Corrigin, WA, AUS	RL Barrett 5885 & MD Barrett, PERTH	KP100462	KP100469
Schizacme				
<i>S. archeri</i> (Hook.f.) Dunlop	Mt Field National Park, Tas, AUS	MJ Henwood 865, SYD	JX046120	JX029167
<i>S. montana</i> (Hook.f. ex Benth.) Dunlop	Mt Wellington, Tas, AUS	MJ Henwood 937, SYD	KP100461	KP100468
<i>S. helmsii</i> (Kirk) K.L.Gibbons (syn. <i>M. montana</i> var. <i>helmsii</i> Kirk)	Saddle between Mount Davey and Sewell Peak, Westland, NZ	D Glenny 11640, CHR624366	KP100459	KP100466
<i>S. novae-zelandiae</i> (Hook.f.) K.L.Gibbons (syn. <i>M. novae- zelandiae</i> Hook.f.)	Minchin Pass Bivouac, Arthur's Pass National Pass, NZ	D Glenny 11049, CHR615667	KP100460	KP100467